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National Transportation Safety Board
Before the
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Subcommittee on Railroads, Pipelines, and Hazardous Materials
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Hazardous Materials Safety Program
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Good afternoon, Chairwoman Brown, Ranking Member Shuster, and the Members of the Subcommittee. Thank you for the opportunity to appear before you today on behalf of the National Transportation Safety Board (NTSB) regarding the safe transportation of hazardous materials. Today, I would like to highlight specific issues of concern to the NTSB, involving the hazards of wet lines on highway cargo tanks and the air transportation of lithium batteries.

Wet Lines on Highway Cargo Tanks

Issue

Gasoline and other hazardous materials can be transported in piping below cargo tanks that can be released onto vehicles in accidents.

Background

Most MC-306 and DOT-406 highway cargo tanks used to transport petroleum distillate fuels are loaded through bottom loading lines and then operated on the roads with cargo in these lines. However, because of their design, location, and vulnerability to being hit by other vehicles on the road, the practice of transporting hazardous materials in loading lines increases the potential seriousness of any accident.

These external pipes or wet lines on a cargo tank semitrailer transporting flammable liquid may contain as much as 50 gallons of product underneath a fully loaded cargo tank. Because the wet lines are designed to break away in order to prevent damage to the tank shell, the wet lines could release a substantial amount of product on a striking passenger vehicle, which may be trapped beneath the cargo tank and engulfed in a fire. This issue predominately applies to tank trucks delivering gasoline to local gas stations.

In 1978, the Office of Motor Carrier Safety within the Federal Highway Administration established a policy allowing gasoline to be carried in wet lines because of "economic and practicality considerations." In 1985, the Pipeline and Hazardous Materials Safety Administration (PHMSA), then known as Research and Special Programs Administration (RSPA), published a notice of proposed rulemaking (NPRM) (Docket Numbers 183 and 183A) that increased the bottom accident damage protection for cargo tanks, including the wet lines. In 1988, in the process of developing the final rule, PHMSA staff prepared an issue outline memorandum that discussed the external piping issue. The memorandum noted:

> It is unreasonable and illogical to allow the piping to be considered as an acceptable container for the transport of gasoline. Therefore, the petroleum industry's decision to bottom load in compliance with the Clean Air Act and their unwillingness or inability to drain the cargo lines has resulted in widespread non-compliance with the intent and letter of the *Hazardous Materials Regulations* as interpreted by RSPA [PHMSA] for the transportation of gasoline.

In the final rule published in 1989, PHMSA noted that wet lines were not appropriate packaging for hazardous materials:

> Bottom loading and unloading outlets on cargo tanks, although very useful, present the inherent risk that if damaged the entire contents of the tank may be released. Piping attached to the outlet valve is provided with a sacrificial device that is designed to break under accident loads…. Because such piping under the current regulation is not specifically a part of the product containment vessel and is designed to fail in an accident, RSPA's [PHMSA'S] position is that piping between the tank outlet valve and any loading valves is not an appropriate packaging for the transportation of hazardous materials… RSPA [PHMSA] strongly believes that the practice of transporting hazardous materials in exposed unprotected piping designed to fail, if impacted in an accident, is an unnecessary risk.

In addressing comments from the petroleum industry regarding data supporting the infrequency of accidents resulting in damage to the wet lines and the loss of lading, PHMSA responded that although such accidents were infrequent, the consequences of such accidents could be substantial. PHMSA encouraged the petroleum industry to consider and evaluate all possible ways to eliminate this risk in the most cost effective manner. The industry responded but not with a solution. The American Petroleum Institute (API) replied that the analysis of wet line accident statistics indicates that the probability is quite low that a fatality will be directly attributed to a wet line failure. Based on the results of its analysis, API cancelled a study to evaluate alternate means of loading cargo tanks that would result in dry loading lines. Consequently, PHMSA prohibited the transportation of poison B liquids, oxidizer liquids, liquid organic peroxides, and liquid corrosives in wet lines, but allowed gasoline and petroleum products in external unprotected wet lines. PHMSA justified the exception for gasoline by the lack of sufficient accident data and the inadequacy of information concerning possible alternative procedures and/or equipment.

Accidents

Subsequent to this rulemaking activity, the NTSB investigated several accidents in which wet lines were damaged, and gasoline in the wet lines was released and ignited. On October 9, 1997, a tractor/cargo tank semitrailer transporting 8,800 gallons of gasoline was struck by a car in Yonkers, New York. The car hit the right side of the cargo tank in the area of the tank's external wet lines, releasing the gasoline in them. The ensuing fire destroyed both vehicles, and the driver of the car was killed. Five months after this accident, the NTSB investigated a similar accident that happened on February 15, 1998, in Wilmington, Delaware. A tractor/cargo tank semitrailer transporting 8,900 gallons of gasoline struck the left rear of a car parked on the right shoulder of a bridge. The truck pushed the car into a concrete barrier bordering the bridge. A fire ensued, destroyed the car, and moderately damaged the truck.

The NTSB determined that three of the four wet lines on the cargo tank fractured during the collision, releasing about 12 gallons of gasoline. As a result of these investigations, the NTSB recommended that PHMSA prohibit the carrying of hazardous materials in external piping of cargo tanks, such as wet lines, which may be vulnerable to failure in an accident (Safety Recommendation H-98-27).

In another accident in Mustang, Oklahoma, in July 1998, local authorities attributed the severity of the accident to the failure of wet lines after an automobile hit a cargo tank and broke the wet lines. The gasoline in the wet lines was released and ignited, engulfing the automobile and cargo tank in fire.

On July 1, 2009, an automobile collided with a cargo tank semitrailer in Upper Pittsgrove Township, New Jersey. The automobile struck a wet line on the cargo tank truck and about 13 gallons of gasoline were released onto the automobile. The wet line did not sever at the point where it is connected to the cargo tank. The wet line was originally about 18 feet long and 4 inches in diameter. Approximately 6 feet of the wet line remained attached to the cargo tank after the accident, extending from where it was attached to the number 4 cargo compartment forward towards the piping manifold. The automobile became wedged beneath the cargo tank truck and a postcrash fire consumed the automobile. The Gloucester County Medical Examiner's Office postmortem report indicated that the cause of death of the automobile driver was smoke and soot inhalation and severe thermal burns. NTSB investigated the accident and determined that the probable cause of the accident was the failure of the automobile driver to obey a stop sign equipped with flashing red lights. Contributing to the severity of the accident was a fire that resulted from the release of gasoline from a cargo tank loading line that was ruptured during the collision.

This recent accident illustrates once again why the NTSB strongly believes that PHMSA should prohibit the unsafe practice of transporting hazardous materials in the external loading lines of cargo tanks.

Action to Date

In December 2004, PHMSA published an NPRM addressing the transportation of flammable liquids in external wet lines. PHMSA noted in the NPRM that 190 accidents involving wet lines were reported in the 12-year period from January 1, 1990, through December 31, 2001, and included at least 7 fatal accidents in which unprotected wet lines were damaged and gasoline was released. PHMSA acknowledged that there was underreporting of hazardous materials transportation accidents of all types. Since this rulemaking activity, the accuracy and adequacy of PHMSA's database has been questioned.

To improve the safety of wet lines, PHMSA proposed to prohibit flammable liquids, including gasoline, in external product piping (that is, wet lines) unless the piping was protected from impact. Two options that would meet this performance standard would be the use of purging systems for existing external piping, or replacing the existing external piping with shortened or recessed piping.

The petroleum industry strongly opposed the NPRM and resisted initiatives to require purging of the wet lines. The API and the National Tank Truck Carriers estimated that 26,000 trailers would be affected.

Sunoco, Inc., on the other hand, was very proactive and made a decision to equip all of its fleet of about 120 cargo tanks with purging systems. Sunoco advised that its vehicles have been equipped for several years and that the systems have worked well. Sunoco identified two accidents in the Philadelphia area where it believes purged lines may have prevented the destruction of its trailers.

In its March 5, 2005, comment letter to PHMSA on the NPRM, the NTSB stated (1) that it did not believe that reliance upon impact damage protection devices for wet lines would provide the greatest level of safety and (2) that the hazards from wet lines full of a hazardous cargo can be more effectively eliminated if the wet lines are purged of the cargo.

On June 7, 2006, PHMSA published a notice withdrawing the NPRM. PHMSA stated in the withdrawal notice that it had concluded that "further regulation would not produce the level of benefits … originally expected and that the quantifiable benefits of proposed regulatory approaches would not justify the corresponding costs."

On July 31, 2007, PHMSA advised the NTSB that while it would not eliminate wet lines, it developed an outreach program focused on best practices for fueling operations, maintenance procedures, and other safeguards. PHMSA also advised that it was working with industry to refine data on the wet line issue. While recognizing these increased activities, the NTSB advised PHMSA on September 4, 2008, that these actions still do not address the need to eliminate wet lines and that they did not satisfy the NTSB's 1998 recommendation.

On October 16, 2009, PHMSA advised the NTSB that it is completing an in-depth comprehensive review of incident reports and other safety data to determine whether rulemaking action to reduce the risks associated with the transportation of hazardous materials in wet lines is necessary. PHMSA also advised that it is evaluating the effectiveness of existing or emerging technologies to address the risk.

Action Needed

The hazard posed by wet lines on cargo tanks making gasoline deliveries has been recognized for 30 years. NTSB believes that PHMSA needs to prohibit this practice. Further, PHMSA acknowledged the underreporting of accident data in its NPRM, and the NTSB believes that PHMSA should take action to improve the accuracy and completeness of the data.

Safety Recommendation

--to the U.S. Department of Transportation:

> Prohibit the carrying of hazardous materials in external piping of cargo tanks, such as loading lines, that may be vulnerable to failure in an accident. (H-98-27); Current classification: Open—Acceptable Response

Air Transportation of Lithium Batteries

Issues

Inadequate understanding of the cause of fires involving lithium batteries and inadequate public awareness about safely carrying lithium batteries on aircraft.

Background

There are two types of lithium batteries: primary and secondary. Primary lithium batteries are non-rechargeable, and they are commonly used in items such as watches and pocket calculators. They contain metallic lithium that is sealed in a metal casing. The metallic lithium will burn when exposed to air if the metal casing is damaged, compromised, or exposed to sustained heating.

Secondary lithium batteries, also known as lithium-ion batteries, are rechargeable and are commonly used in items such as cameras, cell phones, laptop computers, and hand power tools. The secondary lithium batteries contain electrically charged lithium atoms, or ions, in a flammable liquid electrolyte. Overheating of the battery can result in the ignition of the flammable electrolyte. Halon suppression systems (the only fire suppression systems certified for aviation) are not effective in extinguishing fires involving primary lithium batteries, but can be effective in extinguishing fires involving secondary lithium batteries. Between December 2007 and November 2008, the Consumer Product Safety Commission issued 5 recalls of nearly 800,000 secondary lithium batteries because of overheating, melting, or creating a fire hazard.

The demand for primary and secondary lithium batteries has skyrocketed since the mid-1990s as the popularity and use of electronic equipment of all types has similarly grown. As the

use of lithium batteries has increased, the number of incidents involving fires or overheating of lithium batteries, particularly in aviation, has likewise grown. The NTSB has investigated three such accidents, which I would like to review for the Committee.

Los Angeles International Airport, Los Angeles, California

On April 28, 1999, a fire destroyed two cargo pallets that included boxes of primary lithium batteries at Los Angeles International Airport. The pallets had been taken off an inbound passenger-carrying flight from Japan. During the movement of one of the pallets by a forklift within the cargo facility, the pallet fell off the forklift and rolled onto its side against another pallet. The pallet of primary lithium batteries was moved a second time and placed next to another pallet of primary lithium batteries. Three minutes later, smoke and a small fire were observed on the previously overturned pallet. The fire spread to the adjoining pallet of batteries, and both pallets erupted in flames. The fire department extinguished the fire in about 25 minutes only after separating the packages on the pallets and deluging them with water.

Interviews with the air carrier's employees revealed that it was not uncommon to overturn a pallet and that other loads of batteries had been damaged and sometimes resulted in spillage of the batteries.

The lithium batteries on the two pallets were neither identified nor shipped as hazardous materials. Instead, they had been shipped as ordinary freight under an exception to the *Hazardous Materials Regulations*. At the time of this incident, lithium batteries containing limited amounts of lithium and meeting certain packaging requirements were "excepted" (excluded) from all regulations. Lithium batteries not meeting the exception criteria had to be transported as a regulated hazardous material, be identified on the shipping documents, and have appropriately marked and labeled packaging. The batteries involved in this incident met the criteria for the exceptions.

The NTSB's investigation of this incident revealed that these batteries presented an unacceptable risk to aircraft and passengers. The NTSB recommended that PHMSA with the Federal Aviation Administration (FAA), evaluate the fire hazards posed by lithium batteries in an aviation environment and require that appropriate safety measures be taken to protect the aircraft and occupants. The NTSB also recommended that packages containing lithium batteries be identified as hazardous materials, including appropriate marking and labeling of the packages and proper identification in shipping documents when transported on aircraft.

Memphis, Tennessee

On August 4, 2004, fire destroyed freight in a unit load device (a cargo container configured for aircraft) that was being loaded on a cargo-only aircraft in Memphis, Tennessee. As the unit load device was about halfway onto the aircraft, loading personnel smelled smoke and lowered the device to the ground. When fire responders arrived and opened the unit load device, a fire flared inside it.

The fire originated in a cardboard box that held two secondary lithium battery modules that were components of a prototype battery pack for an electric car. The package also contained metal tools taped to a cardboard lining in the top of the box. The accident package was identified on shipping documents as "lithium batteries" and class 9 miscellaneous hazardous materials. The package was shipped under a U.S. Department of Transportation (DOT) "competent authority approval," a formal written authorization for the limited shipment and transportation of a specific hazardous material in specially designed containers or packaging. The DOT approval applied to the complete battery pack and not the individual battery modules. The DOT approval further stipulated that the battery pack was to be secured in an insulated fiberboard case. The fiberboard case was to be enclosed and secured in a wooden crate.

On the basis of this evidence, the NTSB determined that the fire was caused by the failure of unapproved packaging to adequately protect the secondary lithium batteries from short-circuiting during transportation.

In conjunction with its investigation of the Memphis incident, the NTSB requested accident data from PHMSA about other reported incidents involving lithium batteries. According to PHMSA, six other incidents involving lithium batteries in air transportation were reported from January 1989 through May 2005. In five of these incidents, the batteries caused fire or charring of the packaging. During the same period, six incidents involving lithium batteries in other modes were reported, but only one included a fire directly related to the transport of lithium batteries.

The NTSB did not issue any additional safety recommendations as part of its investigation of the Memphis incident. The safety recommendations to evaluate the fire hazards of lithium batteries issued following the 1999 incident in Los Angeles addressed lithium batteries in general. The NTSB believed these recommendations also applied to secondary lithium batteries, and that PHMSA should evaluate the fire hazards of secondary lithium batteries.

Philadelphia, Pennsylvania

The most recent accident that involved lithium batteries and was investigated by the NTSB occurred on February 7, 2006. After an in-flight cargo fire, a cargo aircraft made an emergency landing at its destination airport, Philadelphia International Airport. The aircraft and most of the cargo were destroyed by fire after landing.

The NTSB examined the contents of the cargo containers where the fire most likely originated and found that several electronic devices containing secondary lithium batteries were shipped in these containers. No batteries were found that exhibited any damage identifying a source of ignition, nor could any determination be made that secondary batteries found in the debris had been subject to recalls.

Although the cause of the in-flight fire ultimately could not be determined, the prevalence of electronic equipment in the main cargo compartment caused the NTSB to closely examine safety issues involving the transportation of secondary lithium batteries on commercial aircraft, including batteries in airline passengers' laptop computers and other personal electronic devices. The NTSB concluded from its investigation that testing and incident data indicated that both primary and secondary lithium batteries pose a fire hazard, and that an in-depth analysis of the causes of primary and secondary lithium battery failures would improve the safe transportation of these batteries.

The NTSB issued safety recommendations to PHMSA in December 2007 to address growing concerns about the increasing frequency of rechargeable and non-rechargeable lithium batteries overheating and igniting when transported on aircraft, either as cargo or as items in passenger baggage or carry-on items. Because the causes of these battery failures in many cases remain unknown, the NTSB issued multiple safety recommendations urging PHMSA to address the problems with lithium batteries on a number of fronts, including:

- reporting all incidents,
- retaining and analyzing failed batteries,
- researching the modes of failure, and
- eliminating regulatory provisions that permit limited quantities of these batteries to be transported without labeling, marking, or packaging them as hazardous materials.

In January 2008, the NTSB issued additional recommendations to PHMSA and the FAA to address the NTSB's concerns about the lack of public awareness about issues involving the overheating and ignition of lithium batteries.

Action to Date

In December 2004, PHMSA published an interim final rule that addressed the safety recommendations issued following the 1999 incident in Los Angeles. This rule prohibited the transportation of most cargo shipments of primary lithium batteries on board passenger-carrying aircraft. Cargo shipments of equipment containing small- and medium-sized primary lithium batteries (containing less than 25 grams of lithium) were still permitted on passenger-carrying

aircraft, as were shipments of secondary lithium batteries, including those in equipment and within specified weight restrictions.

On August 9, 2007, PHMSA issued a final rule on the transportation of lithium batteries that became effective on January 1, 2008. The 2007 rule permanently adopted the amendments contained in the December 2004 interim final rule. The 2007 rule also included the following new requirements:

- Testing of the packaging for small lithium batteries;
- Labeling, marking, and packaging for single packages containing 12 or more small lithium batteries;
- Shipments of medium-sized lithium batteries to be transported and identified as class 9 hazardous materials when transported by air (and vessel); and
- Permitting airline passengers and flight and cabin crew to carry spare lithium batteries on aircraft as carry-on items only.

On January 14, 2009, PHMSA published another final rule concerning the transportation of batteries and battery-powered devices on aircraft. This final rule addressed the harmonization of the U.S. *Hazardous Materials Regulations* with international standards for transporting hazardous materials, including lithium batteries, by air. This rule did not address the NTSB's 2007 and 2008 recommendations other than by enhancing the incident reporting requirements for battery failures.

PHMSA Letter to NTSB

On October 16, 2009, PHMSA advised NTSB that it was taking several actions in response to safety recommendations issued in 2007 and 2008. PHMSA stated that they agreed with NTSB that air carriers should be required to report all incidents involving lithium batteries, as evidenced by the final rule issued on January 14. PHMSA advised that incidents involving batteries and battery-powered devices that result in a fire, violent rupture, explosion, or dangerous evolution of heat must be reported, and that immediate telephonic notification is required for incidents involving air transportation. PHMSA also agreed with NTSB that an examination of failed batteries and electronic devices and equipment will provide valuable data and information. Therefore, it developed a standard protocol to be used by aircraft operators in the event of an incident for (1) immediately reporting the incident, (2) preserving the batteries and/or electronic equipment that failed, and (3) obtaining relevant information from passengers and crewmembers.

PHMSA further advised in its letter that it had completed an analysis of the causes of lithium battery incidents, consistent with NTSB's recommendation. PHMSA noted that data suggest that the most likely causes of lithium battery incidents are (1) external short circuiting, (2) improper charging and/or discharging conditions associated with equipment use, (3) non-compliance (faulty design of the battery, false certification with regulatory testing/classification requirements, improper packaging and handling including some counterfeit batteries), and (4) internal short circuiting which can be caused by foreign matter introduced during the manufacturing process or when a battery is physically damaged, such as dropped or punctured.

PHMSA stated that it intends to issue a rulemaking this fall to impose more effective safeguards, including design testing, packaging, and hazard communication measures for various types and sizes of lithium batteries in specific transportation contexts. Specifically, PHMSA advised NTSB that it plans to:

- eliminate current exceptions for small lithium batteries;
- consider requiring manufacturers to provide evidence of satisfactory completion of the UN design type tests for each lithium battery and cell that is offered for transportation;
- revise current shipping descriptions to account for different battery types and chemistries and for consistency with shipping descriptions in international standards and regulations;
- restrict stowage of lithium batteries on an aircraft to crew accessible locations to permit immediate investigation and response to smoke or fire; and,
- consider development of appropriate safety measures for the air transport of lithium cells or batteries identified as defective for safety reasons or damaged.

PHMSA further advised that it and FAA plan to continue to evaluate the risk posed by all types and sizes of lithium batteries with a view toward risk reduction; however, the work will depend on the availability of resources. These areas would include test fire behavior of lithium batteries of various size and packaging configurations; fire resistant containers; analysis of cargo compartment configuration; and fire detection and suppression system methods.

Finally, PHMSA stated that it agrees with NTSB recommendations to establish a process to ensure wide, highly visible, and continuous dissemination of information to the air-traveling public, including flight crews, about the safe carriage of secondary (rechargeable) lithium batteries or electronic devices containing these batteries on board passenger aircraft. It has described to NTSB an education program that involves airlines, associations, and manufacturers to address the issue. NTSB believes that a process for measuring the effectiveness of educational programs is needed before an assessment of success can be accomplished.

Action Needed

NTSB is currently assessing PHMSA's October 16, 2009 response to actions that it is taking to address safety recommendations. However, action is needed to timely complete rulemaking and research commitments that it has made.

Safety Recommendations

--to the Pipeline and Hazardous Materials Safety Administration:

> Require aircraft operators to implement measures to reduce the risk of primary lithium batteries becoming involved in fires on cargo-only aircraft, such as transporting such batteries in fire resistant containers and/or in restricted quantities at any single location on the aircraft. (A-07-104); Current classification: Open—Acceptable Response

Until fire suppression systems are required on cargo-only aircraft, as asked for in Safety Recommendation A-07-99, require that cargo shipments of secondary lithium batteries, including those contained in or packed with equipment, be transported in crew-accessible locations where portable fire suppression systems can be used. (A-07-105); Current classification: Open—Acceptable Response

Require commercial cargo and passenger operators to report to the Pipeline and Hazardous Materials Safety Administration all incidents involving primary and secondary lithium batteries, including those contained in or packed with equipment, that occur either on board or during loading or unloading operations and retain the failed items for evaluation purposes. (A-07-107); Current classification: Open—Acceptable Response

Analyze the causes of all thermal failures and fires involving secondary and primary lithium batteries and, based on this analysis, take appropriate action to mitigate any risks determined to be posed by transporting secondary and primary lithium batteries, including those contained in or packed with equipment, on board cargo and passenger aircraft as cargo; checked baggage; or carry-on items. (A-07-108); Current classification: Open—Acceptable Response

Eliminate regulatory exemptions for the packaging, marking, and labeling of cargo shipments of small secondary lithium batteries (no more than 8 grams equivalent lithium content) until the analysis of the failures and the implementation of risk-based requirements asked for in Safety Recommendation A-07-108 are completed. (A-07-109); Current classification: Open—Acceptable Response

--to the Federal Aviation Administration and the Pipeline and Hazardous Materials Safety Administration:

In collaboration with air carriers, manufacturers of lithium batteries and electronic devices, air travel associations, and other appropriate government and private organizations, establish a process to ensure wider, highly visible, and continuous dissemination of guidance and information to the air-traveling public, including flight crews, about the safe carriage of secondary (rechargeable) lithium batteries or electronic devices containing these batteries on board passenger aircraft. (A-08-1); Current classification: Open—Acceptable Response

In collaboration with air carriers, manufacturers of lithium batteries and electronic devices, air travel associations, and other appropriate government and private organizations, establish a process to periodically measure the effectiveness of your efforts to educate the air-traveling public, including flight crews, about the safe carriage of secondary (rechargeable) lithium batteries or electronic devices containing these batteries on board passenger aircraft. (A-08-2); Current classification: Open—Acceptable Response

Madam Chairwoman, this concludes my prepared testimony, and I would be happy to answer questions at the appropriate time.